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December 13, 1994

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: Ex Parte Contact
PR Docket No. 93-61

Dear Mr. Caton:

Pursuant to Section 1.1206 of the Commission's Rules, notice is hereby given of an ex parte communication regarding the above-referenced proceeding. The instant notice is being submitted in duplicate.

On December 13, 1994, the undersigned and Donald R. Gray and Graham Smith, CEO and Director/Systems Research, respectively, of MobileVision, L.P., met with Bruce A. Franca, Deputy Chief Engineer, and Alan Stillwell, Economics Advisor, Office of Engineering & Technology, concerning various of the issues in this proceeding. A copy of materials that were delivered at the meeting are attached.

Please associate this notice and the attached materials with the record in this proceeding.

Sincerely,

REED SMITH SHAW & McCLAY

John J. McDonnell

cc: Bruce A. Franca (w/o encl.)
Alan Stillwell (w/o encl.)
Rosalind K. Allen (w/encl.)
F. Ronald Netro (w/encl.)
Martin D. Liebman (w/encl.)
John J. Borkowski (w/encl.)
Thomas Dombrowsky (w/encl.)

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Desensitization Calculations for Part 15 devices and Wideband LMS .

G K Smith

December 9, 1994

Revision 1.2

PT15LMS2.DOC

Summary

EXECUTIVE SUMMARY
This is the third technical paper by MobileVision on the subject of interference between Part 15 devices and Wideband LMS systems. This paper uses parameters on various Part 15 devices that have been supplied by the manufacturers and analyzes the interference effects between those particular devices and the various LMS systems.

The conclusions are clear:

- the vaste majority of Part 15 devices will never interfere with Wideband LMS systems
- the type of Part 15 device that has the potential to interfere with Wideband LMS systems is clearly identified
- the need to resolve interference from those devices will be isolated and the means to resolve those isolated events are simple and practical.

and - the numbers of Part 15 devices deployed is not restricted by the existence of the LMS systems.

- there is no significant interference from LMS mobiles to Part 15 devices.
- narrow band transmissions from the LMS fixed sites introduce no practical or added interference problems to Part 15 devices.

In addition, by analyzing the interference of the Metricom system to other Part 15 devices, it is shown that in order for Part 15 devices to co-exist with other Part 15 devices, sophisticated avoidance techniques are required. Thus it is a small step to show that the avoidence of the LMS band, in those few isolated cases, is simple.

SUMMARY OF PAPER
The devices presenting the higher probabilities of interference to LMS fixed sites are, and hence those devices most likely to be required to avoid the LMS sub-band, are in order:

Cylink data modems phones (assuming a frequency in the LMS sub-band is selected).
Metricom concentrator sites
Metricom base sites
Outdoor DS cordless phones (assuming a frequency in the LMS sub-band is selected).

It should be noted that the calculations for the DS cordless phones did not take into account that the device had a 1 in 5 chance of selecting an LMS band. Also no account for the intermittent nature of usage for a phone has been considered. Thus the figures produced are for the time that a cordless phone is actually in use and, in the case of a DS version, on the LMS band. It is probable that the transmit activity on the LMS sub-band could bias the cordless phone away from those frequencies and hence automatically reduce the real interference potential.
Devices such as the Cylink wireless modems present a potential problem in that almost every installation presents a probable interference situation. Similarly, narrow band

transmissions from the LMS site will probably interfere with the Cylink link. The use of directional antennas and antenna height could resolve the situation but it is better that these devices should operate outside the LMS sub-bands.
The required distance of the Metricom bases is very dependent upon the duty factor. and the Metricom bases could easily reduce their interference potential by reducing the effective duty factor. The meter reading systems, Itron and Cellnet, do not present any problems.
The interference to the LMS narrowband channels is less, in the case of DSSS Part 15 devices, and similar, in the case of FH Part 15 devices, to the interference to the location pulses. Hence, the use of narrow band transmissions by LMS systems is incidental. There is no reason at all why the use of narrow band transmissions will effect the level at which an LMS provider will complain of interference from Part 15 devices.

With respect to LMS mobiles interfering with Part 15 devices, the results show that there is no significant interference at all.

The effect of narrowband transmissions by the LMS fixe site are analyzed and the results show that the vaste majority of devices are unaffected, even if they choose to operate in the LMS sub-band. Outdoor video links and Cylink type systems are the only ones likely to be effected but these outdoor pole mounted systems are the ones which present the most interference potential to the LMS sites and hence the interference appears to be mutual. Narrow band transmissions present a very small threat to FH devices, again the vaste majority of devices will be uneffected. The calculations show that the device has to be located very close to the LMS site for the chance of interference and that, even in this case, only a maximum of 2% of the channels could possibly be blocked, assuming 100% capacity of the LMS. There will be no practical interference experienced by the Part 15 devices at all.

The effect of the Pinpoint forward link is analyzed and the results show that if there is co-existence, most devices could be blocked about 30%. The effect on DS cordless phones will depend upon the digital voice implementation. This would need further investigation. The hopping cordless phones will experience less interference and should be OK.

The probability of blocking by the Metricom base stations on other Part 15 devices is calculated in order to establish the degree of interference that Part 15 devices must overcome in order to co-exist. These results do not represent the actual blocking because they do not take into account any of the interference avoidance procedures of the devices but do indicate the degree of potential blocking that needs to be overcome. The results show that the Metricom network is capable of interfering with all the DS devices as well as any other outdoor pole mounted FH device such as Itron. Under typical operating conditions and distances, it is shown that the Cylink and outdoor video systems will be totally blocked, and about 10% of indoor DS phones plus all outdoor DS phones will experience 3% blocking. All indoor video devices will experience 19% blocking. It must be noted that this interference cannot be avoided by selecting other channels as the Metricom system transmits across the entire band and thus will effect all other devices. The blocking to other FH devices is very small.

The results of this paper are in complete agreement with the previous papers and clearly show that the interference from Part 15 devices to the LMS systems is very limited and that it should be very easy to resolve that interference by variation of the frequency, power, antenna height or directivity. In addition, this paper shows that the interference potential can be greatly diminished by adjustment of the transmit duty ratio of the device.

Contents

1. *Part 15 devices Interfering with LMS sites*

1.1. Desensitization of LMS sites

1.1.1. Basic Formulas

Using the 'Egli" propagation formula, the mean level of the unwanted received signal, Pr, is given by the expression:

$$Pr = Pt - 174 + 20 \log (hm\ hb) - f + Ga - 40 \log d$$

where Pt is the transmit power
hm is the height of the mobile antenna, feet
hb is the height of the base antenna, feet
f is the floor attenuation factor
Ga is the gain of the receive antenna
d is the distance of the unwanted transmission, miles

The receive level for desensitization of the LMS site is discussed in Annex A, part 2. The floor attenuation factor, f, is discussed in Annex A, part 3.

1.1.2. Transmit duty factor, Ft.

The effective signal reduction due to the transmit duty factor, Ft, is derived in Annex A, part 7. In Annex B, the parameters of the various Part 15 devices considered in this paper, are given. In addition the effective value of Ft is discussed in each relevant case.

1.1.3. Results

The required distances for a Part 15 transmitter, for 0 10 and 20 dB desensitization of an LMS site are given in Tables 1 and 2.

Tables 3, 3A, 4 and 4A are the calculation of the effective Near-Far-Ratio, NFR, with respect ot the location burst and the narrow band. The equation for the calculation of NFR is given in Annex A, part 4. Tables 3 and 4 therefore 'rank' the devices in their potential interference to LMS sites.

1.1.4. Discussion

1.1.4.1. Location burst

The devices presenting the higher probabilities of interference are:

Cylink data modems (assuming a frequency in the LMS sub-band is selected).
Metricom concentrator sites
Metricom base sites
Outdoor DS cordless phones (assuming a frequency in the LMS sub-band is selected).

It should be noted that the NFR calculation for the DS cordless phones did not take into account that the device had a 1 in 5 chance of selecting an LMS band. Also no account for the intermittent nature of usage for a phone has been considered. Thus the figures produced are for the time that a cordless phone is actually in use and, in the case of a DS version, on the LMS band. It is possible that the transmit activity on the LMS sub-band could bias the cordless phone away from those frequencies and hence automatically reduce the real interference potential.

From Tables 1 and 2, the distances of devices from the LMS sites are given that are required in order to ensure that no desensitization occurs. It can be assumed that the LMS sites are about 8 miles apart.

Devices such as the Cylink wireless modems present a potential problem because the required distance from the LMS site is required to be about 6 miles. Thus almost every installation presents a probable interference problem. The use of directional antennas and antenna height could resolve the situation but it is probable that these devices should operate outside the LMS sub-bands.

The required distance of the Metricom bases is very dependent upon the duty factor. In the typical situation, the required distance is calculated to be 0.6 miles, and, assuming that the bases are 0.5 to 1 mile apart, this would mean that very few bases indeed would cause a problem. The Metricom bases could possibly reduce their interference potential by reducing the effective duty factor. For example, if the device could adjust the number of channels that it used in the LMS sub-band, then the value of Ft would effectively reduce. This would only apply to those bases situated close to an LMS site. The concentrator sites are assumed to be 8 miles apart, and the required distance from the LMS site is calculated to be 3.5 miles, assuming a high transmit duty factor. The concentrator sites use directional radios and thus to resolve interference it may be possible to similarly adjust the channel allocations of the particular radio that is transmitting in the direction of the LMS site in order to reduce the effective value of Ft.

The meter reading systems, Itron and Cellnet do not seem to present any problems.

The video link devices have, in practice, caused desensitization to MobileVision sites. An indoor video link, on demonstration in the window of a Radio Shack store, at a distance of 0.5 miles caused 16 dB desensitization to a MobileVision site. The problem was simply and quickly resolved by switching the device to its alternative channel. As long as there are alternative channels, the remedy is simple. In the case of an outdoor video link within 0.25 miles of a MobileVision site, the device did not have an alternative channel, and thus the problem is more complicated to resolve.

1.4.1.2. Narrow band channels

Comparing Tables 3 and 4 with Tables 3A and 4A shows that the interference to the narrowband channels is less , in the case of DSSS part 15 devices, and similar, in the case of FH Part 15 devices, to the interference to the location pulses. Hence, the use of narrow band transmissions by LMS systems is incidental. There is no reason at all why the use of narrow band transmissions will effect the level at which an LMS provider will complain of interference from Part 15 devices.

Table 1 Effective Desensitization to LMS DSSS and video Devices

	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Pt=	27	27	30	23	30	0	0 dBm
hb=	200	200	200	200	200	200	200 feet
hm=	4	4	30	6	25	25	6 feet
Ga=	9	9	9	9	9	9	9 dBi
Ft=	1	1	1	0.0003	0.03	1	1
f=	10	0	0	0	0	0	10 dB
Pr=	-102	-102	-102	-102	-102	-102	-102 dBm
d=	**2.00**	**3.56**	**11.59**	**0.06**	**1.83**	**1.88**	**0.52 miles**
Pr=	-92	-92	-92	-92	-92	-92	-92 dBm
d=	**1.13**	**2.00**	**6.52**	**0.03**	**1.03**	**1.06**	**0.29 miles**
Pr=	-82	-82	-82	-82	-82	-82	-82 dBm
d=	**0.63**	**1.13**	**3.67**	**0.02**	**0.58**	**0.59**	**0.16 miles**

Table 2 Effective Desensitization to LMS FH devices

	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron meter
Pt=	27	27	32	32	30	-6 dBm
hb=	200	200	200	200	200	200 feet
hm=	4	4	25	25	100	6 feet
Ga=	9	9	9	9	9	9 dBi
Ft=	0.25	0.25	0.01	0.086	0.086	0.0014
f=	10	0	0	0	0	0 dB
Pr=	**-102**	**-102**	**-102**	**-102**	**-102**	**-102 dBm**
d=	**1.00**	**1.78**	**1.19**	**3.48**	**6.21**	**0.02 miles**
Pr=	**-92**	**-92**	**-92**	**-92**	**-92**	**-92 dBm**
d=	**0.56**	**1.00**	**0.67**	**1.96**	**3.49**	**0.01 miles**
Pr=	**-82**	**-82**	**-82**	**-82**	**-82**	**-82 dBm**
d=	**0.32**	**0.56**	**0.38**	**1.10**	**1.96**	**0.01 miles**

Table 3	**Near Far Ratio ref LMS DSSS and video Devices**						
	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Ptw=	40	40	40	40	40	40	40 dBm
Ptu=	27	27	30	23	30	0	0 dBm
hw=	5	5	5	5	5	5	5 feet
hu=	4	4	30	6	25	25	6 feet
JM=	15	15	15	15	15	15	15 dB
f=	10	0	0	0	0	0	10
Ft=	1	1	1	0.0003	0.03	1	1
NFR(eff)=	**9.96**	**5.60**	**1.72**	**332.54**	**10.89**	**10.61**	**38.50**

Table 4	**Near Far Ratio ref LMS FH devices**					
	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron meter
Ptw=	40	40	40	40	40	40 dBm
Ptu=	27	27	32	32	30	-6 dBm
hw=	5	5	5	5	5	5 feet
hu=	4	4	25	25	100	6 feet
JM=	15	15	15	15	15	15 dB
f=	10	0	0	0	0	0 dB
Ft=	0.25	0.25	0.01	0.086	0.086	0.0014
NFR(eff)=	**19.93**	**11.21**	**16.81**	**5.73**	**3.22**	**817.23**

Table 3A	Near Far Ratio ref LMS-narrow band channels DSSS and video Devices						
	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Ptw=	40	40	40	40	40	40	40 dBm
Ptu=	27	27	30	23	30	0	0 dBm
hw=	5	5	5	5	5	5	5 feet
hu=	4	4	30	6	25	25	6 feet
BWw=	25	25	25	25	25	25	25 kHz
BWu=	2	2	4	2.5	2.5	4	4 MHz
f=	10	0	0	0	0	0	10 dB
Ft=	1	1	1	0.0003	0.03	1	1
NFR(eff)=	**12.57**	**7.07**	**2.58**	**443.45**	**14.52**	**15.91**	**57.74**

Table 4A	Near Far Ratio ref LMS-narrow band channels FH devices					
	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron meter
Ptw=	40	40	40	40	40	40 dBm
Ptu=	27	27	32	32	30	-6 dBm
hw=	5	5	5	5	5	5 feet
hu=	4	4	25	25	100	6 feet
BWw=	25	25	25	25	25	25 kHz
BWu=	0.2	0.2	0.16	0.16	0.16	0.2 MHz
f=	10	0	0	0	0	0 dB
Ft=	0.25	0.25	0.01	0.086	0.086	0.0014
NFR(eff)=	**14.13**	**7.95**	**11.27**	**3.84**	**2.16**	**579.59**

2. *LMS Interfering with Part 15 Devices*

2.1. Desensitization by LMS mobiles

2.1.1. Basic Formulas

Using the 'Egli" propagation formula, the mean level of the unwanted received signal, Pr, is given by the expression:

Pru = Ptu - 174 + 20 log (hw hu) - f - 10 log (BWu/BWw) - 40 log d

where Ptu is the transmit power of the unwanted
hw is the height of the wanted transmitter
hu is the height of the unwanted transmitter
f is the floor attenuation factor
BWw is the bandwidth of the receiver
BWu is the bandwidth of the unwanted transmission
d is the distance of the unwanted transmission

If the required signal to noise ratio is SNR and the receiver sensitivity is Prs, then the unwanted signal will desense the receiver if :

Pru ≥ Prs - SNR

Hence, the required distance, Dd, for the threshold of desensitization is given by:

40 log Dd = Ptu - Prs + SNR - 174 + 20 log (hw hu) - f - 10 log (BWu/BWw)

If the bandwidth of the unwanted is less than that of the wanted, then all the signal power of the interfering signal is within the band of the wanted. Hence, if Bwu < Bww, then the term 10 log (BWu/BWw) is zero.
Let the radius of the LMS cell be *r* and assume an even distribution of mobiles over the cell.
Let the maximum number of location bursts per second per cell be *Bmax*. This represents a 100% loaded system which is the worst case scenario.
Thus the mean number of bursts per second, *B*, within the distance *Dd*, will be

$$B = B_{\max} \frac{D_d^2}{r^2}$$

For non-hopping devices, this represents the mean number of interfering signals per second.

For hopping devices, assuming a 20 MHz hopping range, the proportion of hops within the LMS sub band will be BWu/20, which for a 6 MHz LMS band is 30%. Hence, in this case, the mean number of interfering signals per second will be 0.3*B*. This represents the number of blocked hops. If the device is capable of sensing the channels before using it, then the actual interference is much less.

If the duration of the burst is *tp*, then the proportion of time that a device will be blocked, *Tb*, is $Tb = tp\, B$

2.1.2. Number of Location Bursts

Annex D lists the basic parameters of the LMS systems. The number of location bursts per second is dependent upon the duration of the burst. Assuming that CDMA is not in use, only one burst at a time can be scheduled over a number of cells. Assuming a seven cell re-use pattern, the number of bursts per cell will be $1/7tp$ maximum. In the case of the Quiktrak system, five bursts at a time may be scheduled, thus $Bmax=5/7tp$.

The Pinpoint system is capable of 1500 locations per second but data messages often take place which reduces the number of bursts. An average burst duration of 1 ms has been assumed. Thus Bmax=1500 x 300/(7 x 1000).

2.1.3. Results

Tables 5 and 6 show the calculated results for the MobileVision and Teletrac mobiles, Tables 5A and 6A for the Quiktrak mobiles, and Tables 5B and 6B for the Pinpoint mobiles.

From these Tables it can be seen that there is no significant interference at all.

Table 5 Effective Desensitization by LMS mobiles - MobileVision/Teletrac DSSS and video Devices

	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor	
Pt=	40	40	40	40	40	40	40	dBm
hu=	5	5	5	5	5	5	5	feet
hw=	4	4	25	6	25	25	6	feet
BWu=	4	4	4	4	4	4	4	MHz
BWw=	2	2	4	2.5	2.5	4	4	MHz
f=	10	0	0	0	0	0	10	dB
Psens	-100	-100	-95	-105	-105	-90	-90	dBm
SNR	15	15	15	15	15	20	20	dB
d=	**0.71**	**1.26**	**2.81**	**2.18**	**4.44**	**2.81**	**0.77**	**miles**
Range r	8	8	8	8	8	8	8	miles
MobileVision								
tp=	55	55	55	55	55	55	55	ms
Bmax	3	3	3	3	3	3	3	b/sec/ cell
B=	0.02	0.06	0.32	0.19	0.80	0.32	0.02	b/sec
Mean Tb	**0.11**	**0.35**	**1.76**	**1.06**	**4.40**	**1.76**	**0.13**	**%**
Teletrac								
tp=	23	23	23	23	23	23	23	ms
Bmax	6	6	6	6	6	6	6	b/sec/ cell
B=	0.05	0.15	0.77	0.46	1.91	0.77	0.06	b/sec
Mean Tb	**0.11**	**0.35**	**1.76**	**1.06**	**4.40**	**1.76**	**0.13**	**%**

Table 6 Effective Desensitization by LMS mobiles - MobileVision/Teletrac FH devices

	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron
Pt=	40	40	40	40	40	40 dBm
hu=	5	5	5	5	5	5 feet
hw=	4	4	25	25	100	6 feet
BWu=	4	4	4	4	4	4 MHz
BWw=	0.2	0.2	0.16	0.16	0.16	0.2 MHz
f=	10	0	0	0	0	0 dB
Psens	-100	-100	-100	-100	-100	-115 dBm
SNR	15	15	15	15	15	10 dB
d=	**0.40**	**0.71**	**1.67**	**1.67**	**3.35**	**1.54 miles**
Range r	8	8	8	8	8	8 miles
MobileVision						
tp=	55	55	55	55	55	55 ms
Bmax	3	3	3	3	3	3 b/sec/cell
B=	**0.00**	**0.00**	**0.02**	**0.02**	**0.09**	**0.02 b/sec**
Mean Tb	**0.01**	**0.02**	**0.13**	**0.13**	**0.50**	**0.11 %**
Teletrac						
tp=	23	23	23	23	23	23 ms
Bmax	6	6	6	6	6	6 b/sec/cell
B=	**0.00**	**0.01**	**0.05**	**0.05**	**0.22**	**0.05 b/sec**
Mean Tb	**0.01**	**0.02**	**0.13**	**0.13**	**0.50**	**0.11 %**

Table 5A Effective Desensitization by LMS mobiles - Quiktrak DSSS and video Devices

	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Pt=	40	40	40	40	40	40	40 dBm
hu=	5	5	5	5	5	5	5 feet
hw=	4	4	25	6	25	25	6 feet
BWu=	2	2	2	2	2	2	2 MHz
BWw=	2	2	4	2.5	2.5	4	4 MHz
f=	10	0	0	0	0	0	10 dB
Psens	-100	-100	-95	-105	-105	-90	-90 dBm
SNR	15	15	15	15	15	20	20 dB
d=	**0.84**	**1.50**	**2.81**	**2.45**	**4.99**	**2.81**	**0.77 miles**
Range r	20	20	20	20	20	20	20 miles
tp=	278	278	278	278	278	278	278 ms
Bmax	3	3	3	3	3	3	3 b/sec/cell
B=	0.00	0.01	0.05	0.04	0.16	0.05	0.00 b/sec
Mean Tb	**0.03**	**0.08**	**0.28**	**0.21**	**0.88**	**0.28**	**0.02 %**

Table 6A Effective Desensitization by LMS mobiles - Quiktrak FH devices

	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron base
Pt=	40	40	40	40	40	40 dBm
hu=	5	5	5	5	5	5 feet
hw=	4	4	25	25	100	6 feet
BWu=	2	2	2	2	2	2 MHz
BWw=	0.2	0.2	0.16	0.16	0.16	0.2 MHz
f=	10	0	0	0	0	0 dB
Psens	-100	-100	-100	-100	-100	-115 dBm
SNR	15	15	15	15	15	10 dB
d=	**0.47**	**0.84**	**1.99**	**1.99**	**3.98**	**1.83 miles**
Range r	20	20	20	20	20	20 miles
tp=	278	278	278	278	278	278 ms
Bmax	3	3	3	3	3	3 b/sec/cell
B=	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00** b/sec
Mean Tb	**0.00**	**0.01**	**0.07**	**0.07**	**0.28**	**0.06 %**

Table 5B Effective Desensitization by LMS mobiles - Pinpoint DSSS and video Devices

	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Pt=	46	46	46	46	46	46	46 dBm
hu=	5	5	5	5	5	5	5 feet
hw=	4	4	25	6	25	25	6 feet
BWu=	8	8	8	8	8	8	8 MHz
BWw=	2	2	5.2	2.5	2.5	5	5 MHz
f=	10	0	0	0	0	0	10 dB
Psens	-100	-100	-95	-105	-105	-90	-90 dBm
SNR	15	15	15	15	15	20	20 dB
d=	**0.84**	**1.50**	**3.56**	**2.58**	**5.27**	**3.53**	**0.97 miles**
Range r	7	7	7	7	7	7	7 miles
tp=	1	1	1	1	1	1	1 ms
Bmax	64	64	64	64	64	64	64 b/sec/cell
B=	0.93	2.94	16.65	8.76	36.50	16.32	1.24 b/sec
Mean Tb	**0.09**	**0.29**	**1.66**	**0.88**	**3.65**	**1.63**	**0.12 %**

Table 6B Effective Desensitization by LMS mobiles - Pinpoint FH devices

	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron base
Pt=	46	46	46	46	46	46 dBm
hu=	5	5	5	5	5	5 feet
hw=	4	4	25	25	100	6 feet
BWu=	8	8	8	8	8	8 MHz
BWw=	0.2	0.2	0.16	0.16	0.16	0.2 MHz
f=	10	0	0	0	0	0 dB
Psens	-100	-100	-100	-100	-100	-115 dBm
SNR	15	15	15	15	15	10 dB
d=	**0.47**	**0.84**	**1.99**	**1.99**	**3.98**	**1.83 miles**
Range r	7	7	7	7	7	7 miles
tp=	1	1	1	1	1	1 ms
Bmax	64	64	64	64	64	64 b/sec/cell
B=	**0.12**	**0.37**	**2.08**	**2.08**	**8.31**	**1.76 b/sec**
Mean Tb	**0.01**	**0.04**	**0.21**	**0.21**	**0.83**	**0.18 %**

2.2. Narrow Band Interference to Part 15 Devices from LMS Fixed Sites

2.2.1. Basic Points

The derivation of the NFR formula is given in Section 4.2.

It should be noted that the bandwidth occupied by the LMS narrow band transmissions is very limited as it is restricted by the spread spectrum bandwidth and the frequency re-use factor (normally taken as 7). In the present MobileVision system, for example, the bandwidth is in the order of 0.5 MHz (assuming a 5.5 MHz band), and under 100% capacity conditions only one seventh of this, about 100kHz, could actually be occupied. In the future it could be argued that the narrow band transmissions could be increased to be spread across the entire LMS allocation. Even in this scenario, a peak of 27 FH channels could be occupied, i.e.20 %. Because of the intermittent nature of channel demand, the typical occupation would be much less than this.

2.2.2. DSSS and Video Systems

Table 7 shows the required distance, *D*, of the LMS fixed sites in order to present a strong enough signal to be capable of interfering with the Part 15 DSSS and Video devices. This Table corresponds to the case when the device has selected the LMS frequency band and is active. A typical operating disance is given for each device, which in the case of the Cellnet system is assumed to be half the maximum distance. From the typical operating distance and the NFR, the required distance of the LMS site is calculated. This distance shows that unless:

a) an LMS fixed site is closer than this to the Part 15 device,

and b) the LMS site is transmitting a narrow band signal,

and c) the Part 15 device is active within the selected bandwidth,

then it will not interfere.

If the distance between LMS fixed sites is *r*, then the number of Part 15 devices that are in range of the site is :

$$\text{\% of devices in range} = r^2 / \pi D^2$$

As can be seen from Table 7, the only devices practically effected are Cylink and the outdoor video links. The Cylink system, from Tables 1 and 3, is a potential strong interferer to LMS systems and hence the interference is mutual. This type of system probably needs to select a channels outside the LMS sub-band in any case. The outdoor video link is also susceptible to interference, but again only if the LMS band is chosen. Practical interference of the other devices is very unlikely. Any interference avoidence scheme that is neccesary to avoid other Part 15 devices, will automatically be able to deal with the narrow band signals from the LMS site, even if the site is within the distance as given in the Table. Thus, for example, the cordless phones should experience no practical interference at all.

2.2.3. FH Devices

Table 8 shows the required distance, *D*, of the LMS fixed sites in order to present a strong enough signal to be capable of interfering with the Part 15 FH devices. As the FH devices hop over the entire 26 MHz band, the number of transmissions/receptions that can possibly clash with the LMS narrow band transmission, at the moment, is very small. Even in the cases where the device is close to an LMS site, the actual maximum amount of blocking is 2.3%. For example, assuming a 200 kHz Part 15 channel, 130 channels in total, with the present MobileVision scheme, only 3 channels could possibly be blocked even when the LMS site is very close to the Part 15 device, as given by Table 8.

From Table 8 it can be seen that only a small percentage of devices are in range and again it must be emphasized that all these devices will automatically adapt if avoidance is necessary.

The Part 15 devices have had to introduce interference avoidance schemes because of the very large threat presented by other Part 15 devices and systems. In fact, the Itron system transmits its signal on at least 8 different frequencies and the other devices use dynamic frequency replacement in order to avoid other Part 15 devices. (It should also be remembered that the Itron system only occupies 910 - 920 MHz). Thus, there is no practical problem of interference from the LMS narrow band transmissions for the FH Part 15 devices.

2.2.3. Discussion

It is important to note that the narrow band transmissions are restricted to the LMS sub-band, and hence any interference can be completely avoided by simply selecting another channel, in the case of the DS and video devices, or replacing or accepting the small amount of blocked channels, in the case of the FH devices.

Table7 **Near Far Ratio ref LMS fixed site-narrow band channels DSSS and video Devices**

	Phone indoor	Phone outdoor	Cylink	Cellnet meter	Cellnet base	Video outdoor	Video indoor
Ptw=	27	27	30	30	23	0	0 dBm
Ptu=	50	50	50	50	50	50	50 dBm
hw=	4	4	30	25	25	25	6 feet
hu=	200	200	200	200	200	200	200 feet
SNR	15	15	15	6	15	20	20
f=	10	0	0	0	0	0	10 dB
NFR(eff)=	**0.03**	**0.02**	**0.05**	**0.08**	**0.03**	**0.01**	**0.01**
dw=	0.01	0.02	1.00	0.05	0.05	0.10	0.01 miles
du=	**0.35**	**1.26**	**19.36**	**0.63**	**1.59**	**15.91**	**1.83** miles
Range r	8	8	8	8	8	8	8 miles
No in range	0	0	18	0	0	12	0
% in range	0.62	7.80	100.00	1.96	12.36	100.00	16.36

Notes: 1 % in range only refers to those devices choosing the LMS sub-band
2 All devices can choose other bands
3 No practical interference need result

Table 8 **Near Far Ratio ref LMS-narrow band channels FH devices**

	Phone indoor	Phone outdoor	Metricom typical	Metricom peak	Metricom Concentrator	Itron meter
Ptw=	27	27	32	32	32	-6 dBm
Ptu=	50	50	50	50	50	50 dBm
hw=	4	4	25	25	100	6 feet
hu=	200	200	200	200	200	200 feet
SNR=	15	15	15	15	15	10 dB
f=	10	0	0	0	0	0 dB
NFR(eff)=	**0.03**	**0.02**	**0.05**	**0.05**	**0.11**	**0.004**
dw=	0.01	0.02	0.125	0.125	4	0.01 miles
du=	**0.35**	**1.26**	**2.36**	**2.36**	**37.81**	**2.58** miles
Range r	8	8	8	8	8	8 miles
No in range	0	0	0	0	70	0
% in range	0.62	7.80	27.41	27.41	100.00	32.65 %

Notes: 1 % in range only refers to those devices choosing the LMS sub-band
2 Phones & Metricom have dynamic replacement of blocked frequencies
3 Itron transmits on 8 different frequencies
i.e. no practical interference will result to

user.

2.3. Desensitization by Pinpoint Wideband Forward link

Tables 9 and 10 show the calculated results for desensitization by the Pinpoint wideband forward link. In this case the distances over which the transmission is capable of interfering are significantly higher and hence a large number of sites are involved. If the distance between transmission sites is r, then the number of sites that are in range of the device is :

$$\text{No. in range, } Nb = \pi \, D_d^2/r^2$$

The mean number of interfering bursts per base (in range) is the duty cycle of the Pinpoint system, Ft, which is the proportion of time the device is blocked. The proportion of time not blocked is therefore $(1 - Ft)$. For Nb transmissions, the probability of being not blocked is $(1 - Ft)^{Nb}$, and hence the probability of being blocked, Pb, is:

$$Pb = 1 - (1 - Ft)^{Nb}$$

In the case of frequency hopping devices, only a proportion of the hopping channels fall within the wideband, hence the formula is modified to:

$$Pb = 1 - (1 - Ft.BWu/26)^{Nb}$$

Pinpoint state that 70% of the time no station is transmitting, thus, presumably, there is a 30% limit to Pb.

Tables 9 and 10 show that all devices are desensitized by the Pinpoint forward link. Tables 9A and 10A, however, show that if the typical working ranges of the devices are considered, then the blocking probabilities for most devices is very small